spite of what has been recently done with regard to this most fascinating puzzle in astronomy. The remainder of this book deals briefly, among other things, with nebulæ, star clusters, comets and their spectra, spectroscopes, &c. The chapter on atmospheric light phenomena has received but little alteration; in it are described refraction, mirages, halos, twilight, &c., which call for little if any change.

In the third book we are introduced successively to chapters on the distribution of heat on the earth's surface, the pressure of, and disturbances in, the atmosphere, and hygrometry; these may be all included in the word "meteorology." In the science of meteorology very rapid advance has been made, and the last twenty years have witnessed changes which have been sweeping in their nature. Such being the case, we expect to find here considerable alterations and additions, and indeed we are not disappointed, for we find this part "zum grossen Theile gänzlich umgearbeitet." Thus, to mention one or two instances, the Ice age is dealt with at some length, and is accompanied by an excellent map showing the glacial distribution. The paragraphs on the internal heat of the earth are also likewise lengthened, and much new matter inserted. In the section on earthquakes, on the other hand, we fail to notice any reference to Prof. Milne's important work that he has been carrying out in Japan on a truly scientific basis. A brief description of this, and a few words on the seismograph, would have made an interesting addition.

The fourth and last book will be found to have received little alteration. This seems perhaps striking, in the face of the great amount of work that is now being done in this direction. There is no doubt that at present we are rather gathering facts systematically and accurately acquired, than subjecting those already obtained to detailed discussion. Nevertheless we find no changes or additions under the paragraph entitled "das spectrum des Nordlichtes," or any other explanation of this phenomenon than that of De la Rive, indicating that the work done during the last nineteen years has been void of results worthy of mention. In the part on lightning, we are rather surprised to see no reference to photography, which has enlightened us much on this phenomenon, showing us that a forked flash is by no means "instantaneous," to use a word which is rather ambiguous, but lasts, comparatively speaking, a considerable time.

We cannot conclude without referring especially to the admirable illustrations, which throughout the work form a very prominent feature. The plates at the end of the book may be said to be the same as those that appeared in the last edition, but in the case of those in the atlas which accompanies the volume many important alterations and additions have been made. Thus, to mention some of the more important. Those showing the paths of the planets have been revised and much improved. Two rather startling (as regards colour) pictures of the planet Mars (June 3 and 14, 1858), after Secchi, are inserted, also an excellent map of his surface, after Schiaparelli.

Among other very good plates is one of Jupiter and his spots (Warren de la Rue), Saturn (Trouvelot), two of the moon after negatives taken at the Lick Observatory, Mount Hamilton, a lunar crater after Nasmyth, Roberts' Andromeda nebula, and Langley's enlarged picture of sun-spots.

The maps and diagrams referring to the meteorologica and magnetical sections are as numerous as ever, and have all been carefully revised and brought up to date. New pictures of the auroræ, as observed in Kingua Fjord in 1882 and 1883, are also inserted.

In the above rapid survey of the 900 pages which this book contains, one can form an idea of the great difficulty the bringing of such a work as this up to date must have been to the reviser. Having to bear in mind that no part must be more elaborately developed than another, and that the limit of range as regards details must be restricted, Dr. Peters has had no light task before him. Cosmical physics is such a wide-spreading subject, and the information here brought together so plentiful, that the few remarks we have made above fall, for the most part, into insignificance.

As a popular treatise the work should be widely read, and the special index should considerably facilitate the utility of the work in its function as a book of reference.

W. J. LOCKYER.

ALCHEMY AND CHEMISTRY.

The Alchemical Essence and the Chemical Element, an Episode in the Quest of the Unchanging. By M. M. Pattison Muir. Pp. 94. (London: Longmans, Green, and Co., 1894.)

THIS is a very interesting book; its object is stated in a sentence printed on a fly-leaf following the title-page—"This essay is written in the hope that some of the men who exercise their 'wit and reason' in examining the problems of life may help to answer the questions that nature propounds to those of her students who follow the quest of the unchanging."

The author begins by quoting two definitions, one by an alchemist: "There abides in nature a certain form of matter which, being discovered and brought by art to perfection, converts to itself, proportionally, all imperfect bodies that it touches"; and the other by a chemist: "In chemistry we recognise how changes take place in combinations of the unchanging." It may here be said that it would often materially add to the interest of the work if the names of the authors of these and of other quotations in the book had been given.

The difficulties that many have experienced in understanding the writings of the alchemists are accounted for by showing that the names which they used, and which have survived as the names of well-known substances, were applied only to certain principles or properties that matter was supposed to possess: thus the word sulphur represents the principle of changeability, and the word mercury the principle of malleability and lustre which the metals exhibit. The alchemists used expressions of this kind partly to hide their secrets from the uninitiated, and also to preserve themselves from suspicion of dealing with the evil one, who was considered to be the possessor of the earth. The mystical language was derived, to a large extent, from theology, the science which at that time pervaded all the thoughts

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of the learned. Possibly the alchemists really attached some definite meaning to the fantastical terms they used, which meanings are now lost to us.

When the use of the accurate balance was introduced into natural science, it revolutionised the methods of investigation: it now became possible to trace the changes which occur during the interaction of bodies in a way quite different from that employed in earlier times. Thus the alchemist observed only the changes of properties of the substances with which he experimented; the chemist investigates, in addition, the changes of mass which occur when alterations of matter are produced.

It must not be supposed that the early workers were ignorant of the increase of weight which occurs during the calcination, or, as we now call it, the oxidation of metals, but they gave very fanciful explanations of the fact; thus George Wilson, in his "Compleat Course of Chymistry," printed in 1721 (how many students at the present time would rejoice in a complete course of chemistry in 383 pages!) says, when writing of the calcination of lead, "It gains in weight by calcination, because a greater quantity of igneous particles insinuate themselves into the lead, than the sulphurous ones the fire drives out, for in calcination, the acid of the fire, joins itself to the alkali of the lead, and having driven away its combustible sulphur, makes a new and incombustible body."

Mr. Pattison Muir gives some illustrations of the use of the balance, but one of these seems not quite a happy example. He states that when water was evaporated in an open dish and a residue was left, the alchemist "pointed to the earthy matter in the dish as proof of the transformation of water into earth." He afterwards says that a weighed quantity of water was distilled, the distillate was weighed and was found to be less than the original water; "but the sum of the weights of the condensed water and the earthy matter was equal to the weight of the water before boiling," showing that the residue was dissolved in the water used. It is not stated by whom this experiment was made, but it is inferred that it was performed in the early days of quantitative work. As spring water rarely contains more than one-tenth per cent. of dissolved matter, it would have been interesting if the author had informed us what precautions were taken to secure such a result, which would be difficult even with our modern appliances.

By the use of the balance it was found that some substances differed from others, some being composed of different kinds of matter, and hence called compounds, whilst others could not be thus separated, and were regarded as simple bodies or elements. When an element is transformed into a compound, the latter almost invariably possesses properties very different from those of the element, and the element appears to have been destroyed; the alchemist thought that it was really destroyed, but the chemist shows that it is only hidden, and can be obtained from the compound in the same quantity that was used to prepare the compound; moreover, the weight of the compound is invariably equal to the sum of the weights of the elements composing it.

As far as we know at present the elements are unchangeable; however complex the compounds which are formed by their combination, the elements can always be obtained from them with all their original properties. Thus the formations of compounds from elements and the decomposition of compounds into elements are properly called the "changes in combinations of the unchanging." The alchemical principles could not be weighed or measured, so that it was not possible to explain the properties of bodies by the assertion—for it was nothing more—that they contained more or less of these principles.

The author next tells us that the same elements in the same proportions can form compounds with different properties, and then passes on to the laws of multiple proportions, showing how these are accounted for by the theory of atoms. The periodic law is then explained, and it is pointed out that the periodic properties of the elements and of their compounds contrast very strongly with the ideas of the alchemists with regard to the principles that were supposed to account for the different properties of substances. The striking difference between alchemical and chemical reasoning is well illustrated by the history of the theory of combustion, the escape of the principle of fire, as held by the phlogistians to be the cause of combustion, being contrasted with the combination of the burning substance with oxygen, as discovered by Lavoisier.

The author appears to be rather hard on alchemy when he says "the great business of alchemy was to prevent men from coming into close contact with external realities. Alchemy was a manufacturer of blinkers that shut off the objects on either side, and so distorted the vision." No doubt this was in some ways the result of alchemy, but it can hardly be supposed that it was its object. It is difficult to place ourselves, even in imagination, in the position of the alchemists, but we may hope that they were struggling after truth to the best of their powers, their failure being due more to their holding preconceived notions than to a desire to obscure facts.

Some may not agree with the author in classing together alchemists, spiritualists, theosophists, and theologians; though, no doubt, all have erred in making assertions with an insufficient knowledge of facts. So also it seems not quite justifiable to restrict the term science to the investigation of natural phenomena, for surely the study of the moral and spiritual actions of man are also worthy of the name of science. Some may not accept spiritual truths, considering that they are beyond their experience; but it is hardly scientific to deny their existence, any more than it was reasonable for the inhabitants of Flatland to deny the existence of space of three dimensions.

Mr. Pattison Muir's book will well repay perusal; it will appeal not only to the chemist, but also to the general reader, who cannot fail to obtain much insight into the ideas of the alchemist, and also into the accurate methods of the modern chemist. HERBERT MCLEOD.

OUR BOOK SHELF.

Principia Nova Astronomica. By Henry Pratt, M.D. (London: Williams and Norgate, 1894.)

WE confess to having read a great deal of this book, and to have wasted a corresponding amount of time,

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